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CRITICAL HABITAT AND FOOD HABITS OF THE SWIFT FOX (VULPES VELOX)

FINAL REPORT

Critical Habitat and Food Habits of the Swift Fox (*Vulpes velox*)

by Jon Sharps

Introduction

The swift fox (*Vulpes velox*) is roughly the size of a house cat with an adult male weighing an average of six pounds and an adult female around five pounds. Their basic coloration is reddish-brown laterally, brownish-grey dorsally, and white venterally. Further coloration includes a white throat patch and a black-tipped tail and muzzel (Sharps 1977).

The swift fox was reported to be relatively abundant throughout the Great Plains prior to human settlement. The original range of the swift fox extended from the southern portions of the Canadian prairie provinces south through Montana, eastern Wyoming, the Dakotas, Minnesota, and Iowa to the Texas panhandle. Two subspecies were described (Merriam 1902; Hall and Kelson 1959); the northern swift fox (*V. V. hebes*) inhabited the Canadian provinces south to Nebraska, while the southern swift fox (*V. v. velox*) occurred in the southern portion of the range. The closely related kit fox (*Vulpes macrotis*) occurs in the southwest and intermountain region (Rohwer and Kilgore 1973).

Naturalists and furbuyers noted the common occurrence of swift foxes in the northern prairies during the early fur-trading period. In the journals of Alexander Henry, 237 "kit fox" were reportedly taken in northeastern North Dakota, 1800-1806 (Reid and Gannon 1928). Lewis and Clark observed the fox on their travels through the Dakotas and Montana, as did Maximilian, Audubon, and Seton (Bailey 1926). Between 1835-1838, the American Fur Company received 10,614 swift fox pelts from their upper Missouri and Sioux outfits. As evidence of

[U.S.F.S. Rocky Mt. Forest & Range Experiment Station Cooperative Agreement 16-817-CA, RWU-1752, 1980]

the relative abundance and/or vulnerability of the swift fox to trapping, only 1,989 red fox (Vulpes fulva) and 108 grey fox (Urocyon cinereoargenteus) were taken from that region during the same period (Johnson 1969).

With settlement of the Great Plains, swift fox numbers decreased and by 1900 the species was rare in it's northern range. The swift fox was last seen in Saskatchewan in 1928 and in Alberta in 1938 (Beck 1958; Soper 1964). Due to an absence of recent sightings, Hoffman et. al. (1959) reported the swift fox was "probably extinct in Montana". Sightings were not reported in North Dakota from 1915-1970, in South Dakota from 1914-1966, nor in Nebraska from 1901-1953 or 1954 (Pfeifer and Hibbard 1970; McDaniel 1976; Jones 1964).

The decline in fox numbers was associated with the destruction of native prairie, predator and rodent control programs, trapping, hunting, and capture by dogs. Robinson (1953) noted that a kit fox population in Nevada was reduced in a two-year period during coyote (Canis latrans) control work with 1080 stations and coyote-getters. He suggested that small, non-target species such as the kit fox were probably more vulnerable to coyote-getters than the widely-spaced 1080 stations.

Since 1966 only an occasional swift fox sighting was reported from Nebraska, South Dakota, and North Dakota (McDaniel 1976). In 1975 Gerald Deutscher located three den sites in southern Shannon County, South Dakota. Sixteen different swift foxes were observed in this locale during a two-week survey in fall of 1976. These sightings suggested that a small but expanding population was being re-established in western South Dakota, so a more intense study was initiated in 1977 (Hillman and Sharps 1978).

In April 1978 the Department of Game, Fish and Parks and US Forest Service (Rocky Mountain Forest and Range Experiment Station, Rapid City, South Dakota) entered into an agreement (No. 16-817-CA) titled "Critical Habitat and Food Habits of the Swift Fox (Vulpes velox)".

Purpose

The purpose of this study is to provide ecological information on food habits and habitat requirements of the swift fox.

Objectives

1. Locate swift fox study sites.

2. Record information on denning sites, available food sources, vegetation types, soils, and topography.

Study Areas and Methods

A. Study Sites: Two sites with known swift fox populations were chosen for study. The first site is on the Pine Ridge Indian Reservation, Shannon County, South Dakota, approximately 14 miles north of Oglala (Fig. 1). This site is typified by bare soil outcroppings throughout the area. The soil type is primarily clay to sandy-clay-loam. Cattle ranching is the primary occupation in the study area. Topography is broad floodplain to gently sloping to rolling upland short to midgrass prairie bordered by the White River. Annual precipitation averages 41.4 centimeters and annual snowfall averages 78.7 centimeters. Three natal dens were located and studied at Pine Ridge in 1978, and four natal dens were studied in 1979.

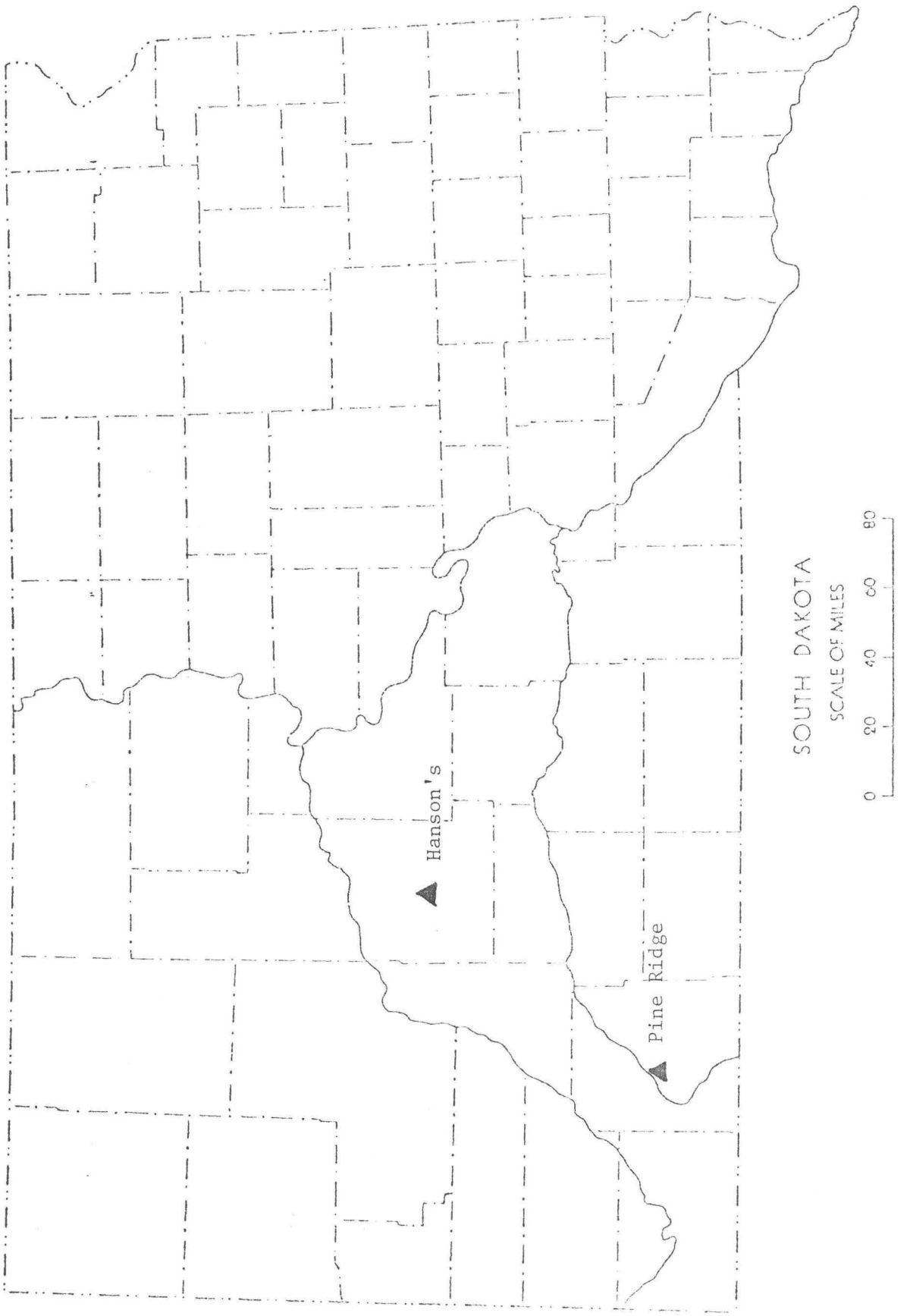

Fig. 1 Location sites of swift fox study areas.

The second site is located in Haakon County, 25 miles north of Philip, on the Bud Hanson Ranch (Fig. 1). This site is typified by rolling short to midgrass prairie and has numerous stockdams located throughout the ranch. The soil is clay-loam. Annual precipitation averages 43.2 centimeters; the annual snowfall averages 30.2 centimeters. Cattle ranching and farming are the primary occupations of the area. One natal den was studied at Hanson's in 1978 and none in 1979. The climate of both areas is characterized by hot summers and cold winters.

B. Methods: Swift fox were located at night by spotlighting. A ground search made the next day usually revealed the den. Located fox were live-trapped using National and Tomahawk traps. Natural bait, such as roadkilled birds and freshly-killed prairie dogs, were used. Supplemental bait, such as sardines and bacon, were also used in the trapping method.

Scats and food remains were collected weekly from each den area and stored in paper bags for later analysis. Food items were preserved by freezing. Scats were prepared for analysis by placing them in nylon bags and washing them in low suds detergent and tag water solution. Analysis of remaining scat material was done by the 100-point-frame method.

Plant characterization measuring relative frequency of occurrence and canopy cover were run at each natal den site along a line transect. Canopy cover provided by herbaceous taxa was measured by reading 30 2x5 decimeter plot frames systematically spaced at one meter intervals on each line transect. Cover for each taxon was ocularly estimated using the method described by Daubenmire (1959). Frequency of occurrence by plant species will be obtained from cover data.

Soils were measured at each natal den site for texture (sand, silt, clay, and rock).

Relative population estimates of small mammal populations were conducted in each den site. In 1978, 25 Sherman live traps were arranged in a line transect with 10-meter spacing. Each trap contained a supply of seeds used as bait. Trapping was conducted for two consecutive days each month at each den site. Trapping done in 1979 was modified to include one live trap (Sherman) and two snap traps (museum special) at each trapping station. There were 25 stations and each station was spaced 10 meters apart for a total of 85 traps per transect line. Pit traps were also included in the transect, however, they were spaced 20 meters apart.

Prairie dogs were estimated by counting active burrows in a 50-meter plot near swift fox dens. A factor of 0.8 prairie dogs per active burrow was used as an approximate indicator of prairie dog density.

Birds were surveyed by a procedure outlined by Emlen (1971), Emlen (1977) and Enderson (1978). An average of 12 transects were run at each natal den site during the 1978 survey, and an average of 8 transects were run at each natal den site during 1979. Each transect was 800 meters in length and had no set width. Species were recorded by cue attenuation and observation.

In 1978 insects were surveyed by placing ten pit traps (#10 cans filled ½ with water) five meters apart along a transect line. Pit traps were opened during a five-day duration and were covered with a small board to prevent livestock from stepping on them. Insects were collected once a month. Insect surveys for coleoptera were not done in 1979.

Grasshopper densities were estimated by walking a 100-meter line transect and counting all grasshoppers observed in 0.09 meter^2 plot every 1-2 meters. A total of 20 plots were estimated per natal den site.

A reference collection of insects was made for future identification purposes.

Amphibians were not recorded.

Findings

Twenty swift fox, eight adults and twelve juveniles, were located and trapped in 1978. Natural food used as bait, such as birds and prairie dogs, proved to be ineffective. Swift fox seemed to be indifferent for the most part to this type of bait. Sardines also proved to be of little value. Bacon, however, was another story and the swift fox responded by readily entering the trap. In some cases, the same fox would enter several times. One adult male at Red Bow's was caught five times. Males were caught over females at a ratio of 1.5:1.0.

During the 1979 field season, bacon was used exclusively for bait. Fourteen swift fox were captured, four adults and ten pups. All of these fox were trapped at the Pine Ridge Indian Reservation. (Hanson's fox were not trapped this year because the adult female was caught earlier in the year in a leghold trap set for a badger and consequently had to have her left front leg amputated.) Males were caught over females at a ratio of 1.4:1.0.

Of the four families of fox studied, three families produced young in 1978 averaging 4.0 pups per litter (one family appeared to be barren). Only three families were studied in 1979, those three families averaging 3.3 pups per litter. The overall average for all families for both years was 3.65 pups per litter.

Two den types were recorded; "natal dens" or those dens used for whelping and "single dens" or those dens used for escape cover or as a resting area. Sometimes it appeared that the fox moved the pups into these single dens to escape ecto-parasite buildups. Food scarcity might have also been a reason for moving.

Natal dens had an average of 5.2 openings in 1978 and 3.5 openings in 1979 per den complex, and single dens had from 1-3 openings per complex. Most dens were found at or near the tops of hills, although one was in a cut bank and several were located in flat areas. Dens usually faced in an easterly direction.

Analysis of scats collected in 1977 and 1978 revealed that swift fox diet consists of four primary food items (mammal, bird, insect, and miscellaneous) (Fig. 2).

Further scat analysis (Fig. 3) shows that of all scats sampled, mammal remains occurred 95 percent of the time, bird 47 percent, insect and miscellaneous occurrences were both 93 percent. Mention should be made here that vegetation material made up the bulk of the miscellaneous percentage. This material was probably injested while eating small mammals, such as prairie dogs and 13-lined ground squirrels which would bring the mammal diet composition up to 75 percent.

Of the 60-75 percent mammalian remains found in the scat analysis, an average of 50-65 percent was prairie dog. This was based on scats collected at Pine Ridge, where all swift fox studied were found within 0.8 km of prairie dog towns.

By comparing available food to habitat, we find that swift fox select highly for mammals over birds and insects (Table 1).

Fig. 2. Analysis of collected scats.

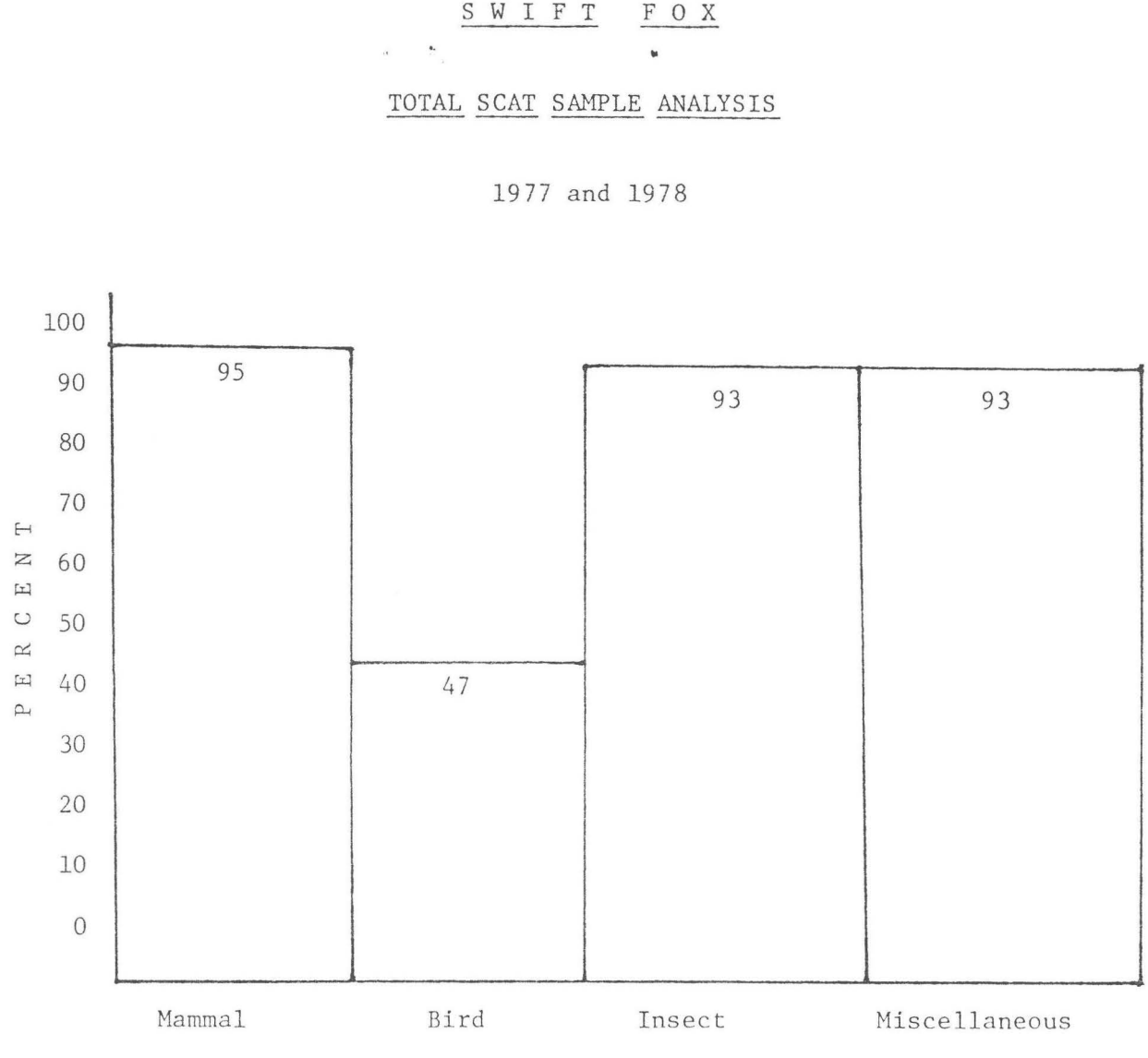

Fig. 3. Total scat sample analysis.

Table 1. Diet vs. habitat availability (percent composition), 1978-79.

	Diet		Habitat	
	1978	1979	1978	1979
Mammal	60	51	<1	<1
Bird	4	10	<1	<1
Insect	21	39	99	99

Relative plant cover measured in 1978 (Table 2) indicated that swift fox did not select den sites for a particular vegetation type such as grasses, forbs, or shrubs. Relative plant cover measured in 1979, using the same transect locations and methods, revealed that grasses were pre-dominant in the selection of a den site (Table 3).

Table 2. Relative plant cover (percent), 1978.

	Spring		Fall	
	Pine Ridge	Hanson's	Pine Ridge	Hanson's
Grasses	88	43	93	61
Forbs	12	57	5	39
Shrubs	--	<1	2	--

Table 3. Relative plant cover (percent), 1979.

	Spring		Fall	
	Pine Ridge	Hanson's	Pine Ridge	Hanson's
Grasses	93	93	93	94
Forbs	7	6	6	4
Shrubs	<1	1	1	2

It would appear that they did select for canopy (ground) cover as shown by Table 4 where all samples averaged 87 percent in 1978 and 83 percent in 1979.

Table 4. Total canopy cover (percent), 1978-79.

	Spring		Fall	
	1978	1979	1978	1979
Pine Ridge	86	80	86	76
Hanson's	89	87	87	90

Vegetation species found in both study areas are listed in Appendix 1 by percent cover and percent frequency.

Soil analysis revealed that swift fox are not selecting for a particular soil type. Each study was composed of a different soil type as shown by Table 5.

Table 5. Soil census at den sites.

Study Area	Soil Type
Pine Ridge (South Church)	Sandy-Clay-Loam
Pine Ridge (Red Bow)	Clay-Loam
Pine Ridge (Bear Nose)	Loam
Hanson's	Clay

Small mammal transects completed in 1978 showed that the prairie dog was the most available mammal to the swift fox. This would not be true for the Hanson study area because there is only one dog town nearby and that town has been losing prairie dogs every year. According to Bud Hanson, owner of this study area, his dog town was 80 acres in size in 1964 and currently is 2-3 acres in size. No reason is known for the decline. Poisoning or shooting were not a factor.

The balance of the small mammals shown in Table 6 are probably not representative of the study areas because of poor sampling technique, resultant sample size, and because of swift fox robbing traps before the investigators could record the results.

Table 6. Small mammal census

Species	Percent Composition 1978	1979
Prairie Dog	36	60
Hispid Pocket Mouse	32	<1
Deer Mouse	18	18
13-Lined Ground Squirrel	9	13
Northern Grasshopper Mouse	5	4
Harvest Mouse	--	<1

Avian transects in 1978 showed that the meadowlark was the most abundant bird species in the study areas (Table 7). During the months of June, July, and August when the transects were run, meadowlark populations remained fairly stable, while morning doves and chestnut-collared longspurs declined in numbers. The same transects run in 1979 showed that the chestnut-collared longspur was the most abundant bird with the meadowlark and horned lark being second and third in abundance respectively.

Results of the 1978 insect surveys showed that there were more orthoptera available; approximately 44,000/hectare as compared to coleoptera, which numbered approximately 7,000/hectare (Table 8). Analysis of the fecal material showed that there were more coleoptera than orthoptera tissue in the samples. We believe the reason for this is because the grasshopper and crickets are softer-bodied and are easier to digest than the more hard-bodied beetles, therefore less orthoptera are represented.

Table 7. Avian census.

Species	Percent Composition 1978	1979
Meadowlark	29	26
Chestnut-Collared Longspur	17	36
Morning Dove	15	2
Horned Lark	7	17
Redwinged Blackbird	5	1
Lark Bunting	5	6
Unknown	9	4
Miscellaneous	13	1

Table 8. Insect density (hectare) at study sites, 1978-79.

	Average 1978	1979
Orthoptera	43,935	98,136
Coleoptera	6,770	--

Summary

Swift fox prefer short to midgrass prairie ecosystems with available water supply in close proximity. Dens are placed near tops of slopes and hills and generally face east. Soil is not a selection factor when choosing a den site, but canopy cover seems to be. Most dens are adjacent to prairie dog towns and mammals are preferred as food over birds and insects. Swift fox are easy to live trap if bacon is used as bait. Management considerations introducing reintroduction or maintaining swift fox populations should include site selection, food availability, and human harassment degree.

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APPENDIX 1

BEAR NOSE

Percent Cover by Species

Species	1978 Spring $\bar{x}$	1978 Spring SE	1978 Fall $\bar{x}$	1978 Fall SE	1979 Spring $\bar{x}$	1979 Spring SE	1979 Fall $\bar{x}$	1979 Fall SE
Grasses:								
Agropyron smithii	33.3	2.7	20.6	7.1	9.1	7.6	13.9	11.3
Andropogon scoparius	--	--	29.1	0.1	17.9	1.2	22.3	1.7
Aristida longiseta	--	--	9.6	0.3	--	--	5.3	1.3
Bouteloua curtipendula	--	--	--	--	1.8	1.8	6.7	5.5
Bouteloua gracilis	11.8	2.4	13.5	3.0	0.2	0.2	18.2	8.7
Bromus japonicus	1.5	0.3	1.5	0.3	--	--	--	--
Bromus tectorum	5.3	1.8	0.8	0.3	2.5	2.5	--	--
Buchloe dactyloides	27.3	11.7	32.0	11.6	44.3	5.5	22.5	5.8
Carey heliophila	5.4	0.1	<0.1	<0.1	0.7	0.7	0.6	0.5
Festuca octoflora	9.7	2.1	11.1	9.8	--	--	--	--
Koeleria cristata	3.3	1.0	5.5	2.7	0.9	0.9	--	--
Sitanian hysterix	5.6	5.6	--	--	0.5	0.5	--	--
Stipa comata	25.4	3.8	--	--	15.4	2.0	--	--
Sporobolaus cryptandrus	0.3	0.3	--	--	--	--	--	--
Forbes:								
Asclepias pumila	0.6	0.5	--	--	2.0	0.5	0.4	0.3
Astragalus spp.	--	--	--	--	0.2	0.2	1.4	0.3
Dalea enneandra	--	--	0.9	0.4	<0.1	<0.1	0.2	0.2
Gaura coccinea	0.8	0.2	--	--	0.6	0.5	0.4	0.3
Hedoma drummondi	2.6	<0.1	--	--	--	--	--	--
Linum rigidum	0.1	<0.1	0.1	0.1	--	--	--	--
Lygodesmia juncea	1.8	0.6	2.8	2.3	1.0	0.9	1.2	0.5
Opuntia spp.	0.5	0.5	--	--	<0.1	<0.1	--	--
Penstemon spp.	--	--	0.3	0.3	--	--	--	--
Petalostemon purpenm	1.3	<0.1	--	--	--	--	--	--
Plantago spp.	0.1	<0.1	0.1	0.1	--	--	--	--
Polygala alba	2.7	0.9	--	--	2.5	1.9	--	--
Psoralea argophyla	2.0	0.5	1.4	0.4	0.5	<0.1	<0.1	<0.1
Sphaeralcea coccinea	0.7	0.7	0.1	0.1	1.3	0.4	<0.1	<0.1
Townsendia grandiflora	--	--	--	--	0.3	0.3	--	--
Tragopogon spp.	1.6	1.6	--	--	--	--	--	--
Verbena bracteata	--	--	--	--	--	--	0.5	0.4
Unknown forb	0.1	0.1	--	--	--	--	0.5	0.5
Shrubs:								
Artemesia dracunculoides	--	--	5.4	0.5	--	--	3.1	2.0
TOTALS	143.8	37.4	134.8	39.4	101.7	27.6	97.2	39.3

RED BOW

Percent Cover by Species

Species	1978 Spring x̄	1978 Spring SE	1978 Fall x̄	1978 Fall SE	1979 Spring x̄	1979 Spring SE	1979 Fall x̄	1979 Fall SE
Grasses:								
Agropyron smithii	9.3	2.0	12.2	3.5	9.4	5.1	7.7	3.2
Aristida longiseta	1.5	1.5	1.3	0.7	--	--	0.5	0.4
Boutelona gracilis	43.2	3.2	31.0	2.0	5.3	2.5	38.1	6.0
Bromus japonicus	--	--	--	--	0.8	0.8	--	--
Bromus tectorum	1.0	0.3	5.0	5.0	1.7	1.7	--	--
Buchloe dactyloides	8.4	2.9	55.4	3.4	52.0	5.2	11.9	5.6
Carey heliophila	14.6	5.5	8.0	7.0	--	--	5.1	1.9
Festuca octoflora	0.9	0.8	1.3	1.3	--	--	--	--
Koeleria cristata	0.9	0.7	--	--	--	--	--	--
Poa sandbergei	2.1	2.1	--	--	--	--	--	--
Schedonnardus paniculatus	--	--	--	--	--	--	0.2	0.2
Sporobolus cryptandrus	1.7	0.1	--	--	2.3	1.6	10.0	7.5
Stipa comata	5.5	4.5	--	--	1.4	1.4	0.6	0.1
Stipa viridula	0.3	0.3	--	--	--	--	--	--
Forbes:								
Allium spp.	0.3	0.3	--	--	<0.1	<0.1	--	--
Antennaria spp.	1.3	1.3	--	--	0.7	0.7	--	--
Astragalus spp.	0.3	0.3	--	--	<0.1	<0.1	--	--
Bahia spp.	--	--	--	--	--	--	<0.1	<0.1
Cryptantha minima	0.6	0.3	--	--	0.1	0.1	--	--
Cryptanthus jamesei	--	--	0.3	0.3	--	--	--	--
Erysimum asperum	0.3	0.3	--	--	--	--	--	--
Gaura coccinea	0.3	0.3	--	--	--	--	2.5	1.9
Hedoma drummondi	--	--	1.1	0.5	--	--	--	--
Helianthus annus	0.3	0.2	--	--	3.2	3.2	1.9	1.4
Holosteum umbulatum	<0.1	<0.1	--	--	--	--	--	--
Lapulla redowskii	3.7	2.3	0.4	0.3	0.3	0.3	--	--
Lepidium densiflorum	0.7	0.3	--	--	--	--	--	--
Lesquerella ludoviciana	--	--	--	--	--	--	0.2	0.2
Linum rigidum	1.2	0.7	0.9	0.3	<0.1	<0.1	--	--
Lygodesmia juncea	--	--	1.0	1.0	--	--	--	--
Opuntia spp.	--	--	--	--	0.2	0.2	--	--
Phlox hoodii	--	--	--	--	<0.1	<0.1	--	--
Plantago purshii	--	--	--	--	<0.1	<0.1	--	--
Plantago spinosa	--	--	1.5	0.2	--	--	--	--
Psoralea argophyla	--	--	--	--	0.3	0.3	--	--
Psoralea tenniflora	<0.1	<0.1	--	--	--	--	--	--
Saljola kali	<0.1	<0.1	--	--	--	--	--	--
Sphaeralcea coccinea	6.4	0.4	4.3	0.6	3.7	2.0	3.5	0.4
Townsendia grandiflora	--	--	--	--	0.6	0.6	--	--
Tragopogon dubins	0.5	0.5	--	--	--	--	--	--
Verbena bracteata	0.3	0.3	--	--	--	--	--	--
Unknown forb	<0.1	<0.1	0.3	0.3	--	--	--	--
Shrubs: (none)								
TOTALS	105.6	31.4	124.0	26.4	82.0	25.7	82.2	28.8

SOUTH CHURCH

Percent Cover by Species

Species	1978 Spring $\bar{x}$	1978 Spring SE	1978 Fall $\bar{x}$	1978 Fall SE	1979 Spring $\bar{x}$	1979 Spring SE	1979 Fall $\bar{x}$	1979 Fall SE
Grasses:								
Agropyron smithii	3.7	3.7	8.0	3.0	3.4	2.8	0.5	0.5
Aristida longiseta	--	--	20.4	1.5	--	--	--	--
Boutelona gracilis	5.4	0.3	19.4	2.5	0.8	0.3	32.5	2.3
Bromus japonicus	9.7	6.7	--	--	--	--	--	--
Bromus tectorum	11.6	8.7	15.6	3.8	10.9	10.4	<0.1	<0.1
Buchloe dactyloides	27.0	1.5	38.5	1.2	55.7	15.2	16.6	5.2
Carey heliophila	34.8	0.0	27.1	1.0	43.0	5.5	25.8	6.5
Festuca octoflora	2.3	1.0	--	--	--	--	--	--
Stipa comata	20.1	2.0	--	--	8.1	4.3	8.1	4.0
Forbes:								
Applopappus spinulosus	--	--	--	--	--	--	<0.1	<0.1
Astragalus spp.	0.3	0.3	--	--	--	--	--	--
Aster ertcoides	--	--	--	--	--	--	<0.1	<0.1
Gaura coccinea	--	--	--	--	--	--	0.2	0.2
Hedoma drummondi	0.4	0.3	--	--	--	--	--	--
Helianthus annus	--	--	--	--	<0.1	<0.1	<0.1	<0.1
Lappula redowskii	--	--	--	--	<0.1	<0.1	--	--
Lepidium densiflora	0.5	0.3	--	--	--	--	--	--
Linum riaidum	0.7	0.5	--	--	--	--	--	--
Lygodesmia juncea	1.8	0.8	2.8	1.8	0.4	0.2	1.6	0.1
Mammilaria vivipara	0.3	0.3	--	--	<0.1	<0.1	--	--
Opuntia spp.	1.0	0.4	0.8	0.3	0.5	<0.1	0.5	0.5
Penstemon albidus	--	--	--	--	--	--	0.2	0.2
Plantago spinosa	--	--	<0.1	<0.1	--	--	--	--
Plantago spp.	0.9	0.5	<0.1	<0.1	--	--	--	--
Psoralea argophyla	<0.1	<0.1	--	--	--	--	--	--
Psoralea tenuaflora	0.3	0.3	--	--	--	--	--	--
Psoralea spp.	--	--	--	--	0.2	0.2	--	--
Sphaeralcea coccinea	0.8	0.7	1.1	0.5	1.8	0.5	0.8	0.7
Unknown forb	0.8	0.8	0.4	0.2	--	--	--	--
Shrubs:								
Artemesia dracunculoides	--	--	--	--	0.8	0.3	0.8	0.8
TOTALS	122.4	29.1	134.1	15.8	125.6	39.7	87.6	21.0

HANSON'S

Percent Cover by Species

Species	1978 Spring $\bar{x}$	1978 Spring SE	1978 Fall $\bar{x}$	1978 Fall SE	1979 Spring $\bar{x}$	1979 Spring SE	1979 Fall $\bar{x}$	1979 Fall SE
Grasses:								
Agropyon smithii	45.1	5.4	51.1	6.6	36.2	6.4	25.3	0.6
Bouteloua gracilis	15.6	0.1	28.2	1.7	16.7	0.5	39.4	1.4
Bromus japonicus	0.6	0.4	--	--	0.1	0.1	--	--
Buchloe dactyloides	16.4	4.5	14.3	1.8	49.2	1.6	58.1	16.6
Carex heliophila	4.1	1.8	0.6	0.6	13.3	0.6	9.4	5.8
Festuca spp.	--	--	0.9	0.9	--	--	--	--
Koeleria cristata	--	--	0.6	0.6	--	--	--	--
Stipa comata	0.3	0.3	--	--	--	--	--	--
Stipa viridula	0.3	0.3	--	--	0.6	0.6	--	--
Unknown grass	2.0	2.0	--	--	--	--	--	--
Forbes:								
Allium spp.	9.1	1.5	--	--	--	--	--	--
Antennaria spp.	3.8	3.8	--	--	--	--	--	--
Astragalus crassicarpus	--	--	--	--	0.2	0.2	--	--
Astragalus spp.	0.3	0.3	--	--	0.7	0.2	0.3	0.1
Chenopodium alba	0.3	0.2	0.5	0.5	--	--	--	--
Descurania pinnata	7.5	0.8	--	--	--	--	--	--
Erysimum asperum	1.3	0.8	0.5	<0.1	--	--	--	--
Grindelia squarrosa	5.9	0.6	9.9	5.4	1.4	0.6	--	--
Hedoma drummondi	<0.1	<0.1	--	--	--	--	--	--
Helianthus petiolaris	1.3	0.7	--	--	<0.1	<0.1	--	--
Holosteum umbulatum	<0.1	<0.1	--	--	--	--	--	--
Hydrophyllia spp.	<0.1	<0.1	--	--	--	--	--	--
Kochia scoparia	--	--	0.3	0.3	--	--	--	--
Lappula redowskii	14.1	2.0	--	--	0.7	0.2	--	--
Lepidium densiflorum	--	--	15.7	15.7	--	--	--	--
Lepidium virginicum	45.4	1.5	--	--	--	--	--	--
Liatris punctata	--	--	--	--	--	--	38.6	1.6
Linum viaidum	0.6	0.6	--	--	--	--	--	--
Medicago lupilina	0.5	0.3	3.0	3.0	<0.1	<0.1	--	--
Melilotus officianalis	10.2	1.2	7.0	3.0	--	--	0.2	0.2
Musineon divaricatum	2.8	0.3	0.9	0.9	--	--	--	--
Opuntia spp.	0.6	0.0	0.3	0.2	<0.1	<0.1	0.1	0.1
Phlox hoodii	1.1	0.6	--	--	2.6	0.7	<0.1	<0.1
Plantago spp.	0.3	0.3	--	--	--	--	--	--
Sphaeralcea coccinea	0.9	0.8	1.9	0.4	1.0	0.2	1.5	0.2
Thlaspi arvense	3.9	2.3	4.8	0.5	--	--	--	--
Trifolium spp.	--	--	--	--	0.9	0.9	0.2	<0.1
Vicia spp.	2.3	0.2	--	--	--	--	<0.1	<0.1
Unknown forb	--	--	0.6	0.4	--	--	<0.1	<0.1

HANSON'S

Percent Cover by Species

Species	1978 Spring $\bar{x}$	1978 Spring SE	1978 Fall $\bar{x}$	1978 Fall SE	1979 Spring $\bar{x}$	1979 Spring SE	1979 Fall $\bar{x}$	1979 Fall SE
Shrubs:								
Artemesia dracunculoides	--	--	--	--	0.5	0.0	0.8	0.8
Artemesia cana	--	--	--	--	0.7	0.7	--	--
Artemesia filifolia	<0.1	<0.1	--	--	--	--	2.2	2.2
TOTALS	196.6	33.5	141.1	42.5	124.8	13.5	141.3	29.6

PERCENT FREQUENCY BY SPECIES

BEAR NOSE

Species	1978 Spring $\bar{x}$	1978 Spring SE	1978 Fall $\bar{x}$	1978 Fall SE	1979 Spring $\bar{x}$	1979 Spring SE	1979 Fall $\bar{x}$	1979 Fall SE
Grass:								
Agropyron smithii	76.7	3.3	53.3	6.7	25.0	15.0	41.6	18.3
Andropogon scoparius	--	--	56.7	3.3	36.6	3.3	41.6	8.3
Aristida longiseta	1.7	1.7	26.7	6.7	--	--	36.6	6.6
Bouteloua curtipendula	--	--	--	--	10.0	10.0	16.6	13.3
Bouteloua gracilis	30.0	3.3	25.0	1.7	1.6	1.6	53.3	13.3
Bromus japonicus	11.7	8.3	5.0	1.7	--	--	--	--
Bromus tectorum	26.7	0.0	6.7	3.3	6.6	6.6	--	--
Buchloe dactyloides	58.3	11.7	61.7	18.3	75.0	1.6	48.3	11.6
Carey heliophila	28.3	1.7	1.7	1.7	6.6	6.6	10.0	3.3
Festuca octoflora	38.3	5.0	18.3	15.0	--	--	--	--
Koeleria cristata	11.7	1.7	20.0	3.3	5.0	5.0	--	--
Sitanian hysterix	10.0	10.0	--	--	3.3	3.3	--	--
Stipa comata	48.3	8.3	--	--	50.0	10.0	--	--
Sporobolaus cryptandrus	1.7	1.7	--	--	--	--	--	--
Forb:								
Asclepias pumila	8.3	1.7	--	--	18.3	8.3	10.0	6.6
Astragalus spp.	--	--	--	--	1.6	1.6	15.0	5.0
Dalea enneandra	--	--	3.3	0.0	1.6	1.6	1.6	1.6
Gaura coccinea	15.0	8.3	--	--	8.3	5.0	8.3	5.0
Hedoma drummondi	21.7	1.7	--	--	--	--	--	--
Linum rigidum	5.0	1.7	3.3	3.3	--	--	--	--
Lygodesmia juncea	21.7	8.3	16.7	13.3	10.0	3.3	16.6	3.3
Opuntia spp.	3.3	3.3	--	--	1.6	1.6	--	--
Penstemon spp.	--	--	1.7	1.7	--	--	--	--
Petalostemon purpenm	5.0	1.7	--	--	--	--	--	--
Plantago spp.	5.0	1.7	3.3	3.3	--	--	--	--
Polygala alba	13.3	3.3	--	--	15.0	8.3	--	--
Psoralea argophyla	15.0	5.0	6.7	0.0	6.6	3.3	1.6	1.6
Psorlea tenniflora	<0.1	<0.1	--	--	--	--	--	--
Sphaeralcea coccinea	10.0	10.0	5.0	5.0	--	--	3.3	3.3
Townsendia grandiflora	--	--	--	--	5.0	5.0	--	--
Tragopogon spp.	1.7	1.7	--	--	--	--	--	--
Verbena bracteata	--	--	--	--	--	--	5.0	1.6
Unknown forb	6.1	2.7	3.3	3.3	--	--	--	--
Shrub:								
Artemesia dracunculoides	--	--	23.3	3.3	8.3	5.0	11.6	1.6
TOTALS	474.5	107.8	341.7	94.9	296.0	106.0	321.0	104.3

PERCENT FREQUENCY BY SPECIES

RED BOW

Species	1978 Spring $\bar{x}$	1978 Spring SE	1978 Fall $\bar{x}$	1978 Fall SE	1979 Spring $\bar{x}$	1979 Spring SE	1979 Fall $\bar{x}$	1979 Fall SE
Grass:								
Agropyron smithii	23.3	3.3	20.0	6.7	46.6	6.6	20.0	10.0
Aristida longiseta	11.7	11.7	10.0	3.3	--	--	5.0	1.6
Boutelona gracilis	80.0	0.0	70.0	6.7	23.3	6.6	80.0	6.6
Bromus japonicus	--	--	--	--	3.3	3.3	--	--
Bromus tectorum	8.3	1.7	10.0	10.0	6.6	6.6	--	--
Buchloe dactyloides	23.3	10.0	90.0	3.3	91.6	8.3	46.6	6.6
Carey heliophila	45.0	1.7	25.0	18.3	--	--	50.0	3.3
Festuca octoflora	18.3	15.0	3.3	3.3	--	--	--	--
Koeleria cristata	--	--	--	--	--	--	--	--
Poa sandbergei	11.7	11.7	--	--	--	--	--	--
Schedonnardus paniculatus	--	--	--	--	--	--	1.6	1.6
Sporobolus cryptandrus	10.0	3.3	--	--	13.3	3.3	5.0	1.6
Stipa comata	11.7	5.0	--	--	8.3	8.3	10.0	3.3
Stipa viridula	3.3	3.3	--	--	--	--	--	--
Forb:								
Allium spp.	1.7	1.7	--	--	--	--	--	--
Antennaria spp.	10.0	10.0	--	--	5.0	5.0	--	--
Astragalus spp.	1.7	1.7	--	--	1.6	1.6	--	--
Bahia spp.	--	--	--	--	--	--	1.6	1.6
Cryptantha minima	15.0	5.0	--	--	5.0	5.0	--	--
Cryptanthus jamesei	--	--	3.3	3.3	--	--	--	--
Erysimum asperum	--	--	--	--	--	--	--	--
Gaura coccinea	5.0	5.0	--	--	--	--	13.3	6.6
Hedoma drummondi	--	--	10.0	3.3	--	--	--	--
Helianthus annus	10.0	6.7	--	--	13.3	13.3	11.6	8.3
Holosteum umbulatum	1.7	1.7	--	--	--	--	--	--
Lapulla redowskii	33.3	13.3	8.3	1.7	5.0	5.0	--	--
Lepidium densiflorum	28.3	11.7	--	--	--	--	--	--
Lesquerella ludoviciana	--	--	--	--	--	--	3.3	3.3
Linum rigidum	15.0	11.7	10.0	3.3	1.6	1.6	--	--
Lygodesmia juncea	--	--	1.7	1.7	--	--	1.6	1.6
Opuntia spp.	--	--	--	--	1.6	1.6	--	--
Phlox hoodii	--	--	--	--	1.6	1.6	--	--
Plantago purshii	--	--	--	--	1.6	1.6	--	--
Plantago spinosa	28.3	11.7	20.0	0.0	--	--	--	--
Psoralea argophyla	--	--	--	--	--	--	--	--
Psoralea tenniflora	1.7	1.7	--	--	6.6	6.6	--	--
Saljola kali	1.7	1.7	--	--	--	--	--	--
Sphaeralcea coccinea	45.0	1.7	26.7	6.7	36.6	16.6	36.6	6.6
Townsendia grandiflora	--	--	--	--	8.3	8.3	--	--
Tragopogon dubins	3.3	3.3	--	--	--	--	--	--
Verbena bracteata	5.0	5.0	--	--	--	--	--	--
Unknown forb	13.4	13.4	1.7	1.7	--	--	--	--
Shrubs: (none)	--	--	--	--	--	--	--	--
TOTALS	466.7	173.7	310.0	73.3	280.8	110.8	286.2	62.6

PERCENT FREQUENCY BY SPECIES

SOUTH CHURCH

Species	1978 Spring $\bar{x}$	1978 Spring SE	1978 Fall $\bar{x}$	1978 Fall SE	1979 Spring $\bar{x}$	1979 Spring SE	1979 Fall $\bar{x}$	1979 Fall SE
Grass:								
Agropyron smithii	20.0	20.0	25.0	1.7	23.3	16.6	6.6	6.6
Aristida longiseta	--	--	65.0	1.7	--	--	--	--
Boutelona gracilis	25.0	1.7	60.0	3.3	3.3	0.0	93.3	0.0
Bromus japonicus	51.7	15.0	--	--	--	--	--	--
Bromus tectorum	38.3	5.0	48.3	8.3	18.3	15.0	1.6	1.6
Buchloe dactyloides	83.3	0.0	98.3	1.7	93.3	6.6	65.0	15.0
Carey heliophila	100.0	0.0	91.7	1.7	91.6	8.3	100.0	0.0
Festuca octoflora	16.7	0.0	--	--	--	--	--	--
Stipa comata	70.0	16.7	--	--	38.3	15.0	51.6	18.3
Forb:								
Applopappus spinulosus	--	--	--	--	--	--	1.6	1.6
Astragalus spp.	1.7	1.7	--	--	--	--	--	--
Aster ertcoides	--	--	--	--	--	--	1.6	1.6
Gaura coccinea	--	--	--	--	--	--	3.3	3.3
Hedoma drummondi	8.3	5.0	--	--	--	--	--	--
Helianthus annus	--	--	--	--	3.3	3.3	1.6	1.6
Lappula redowskii	--	--	--	--	1.6	1.6	--	--
Lepidium densiflora	18.3	11.7	--	--	--	--	--	--
Linum riaidum	10.0	3.3	--	--	--	--	--	--
Lygodesmia juncea	20.0	3.3	21.7	15.0	10.0	3.3	15.0	5.0
Mammilaria vivipara	1.7	1.7	--	--	1.6	1.6	--	--
Opuntia spp.	6.7	0.0	8.3	5.0	6.6	3.3	6.6	3.3
Penstemon albidus	--	--	--	--	--	--	1.6	1.6
Plantago spinosa	--	--	1.7	1.7	--	--	--	--
Plantago spp.	28.3	11.7	1.7	1.7	--	--	--	--
Psoralea argophyla	1.7	1.7	--	--	--	--	--	--
Psoralea tenuaflora	5.0	5.0	--	--	--	--	--	--
Psoralea spp.	--	--	--	--	1.6	1.6	--	--
Sphaeralcea coccinea	16.7	10.0	11.7	1.7	23.3	6.6	10.0	6.6
Unknown forb	1.7	1.7	6.7	0.0	--	--	--	--
Shrub:								
Artemesia dracunculoides	--	--	6.7	0.0	3.3	0.0	3.3	3.3
TOTALS	525.1	115.2	446.8	43.5	319.4	82.8	362.7	69.4

PERCENT FREQUENCY BY SPECIES

HANSON'S

Species	1978 Spring $\bar{x}$	1978 Spring SE	1978 Fall $\bar{x}$	1978 Fall SE	1979 Spring $\bar{x}$	1979 Spring SE	1979 Fall $\bar{x}$	1979 Fall SE
Grass:								
Agropyon smithii	93.3	3.3	90.0	3.3	85.0	8.3	78.3	8.3
Bouteloua gracilis	45.0	1.7	68.3	5.0	45.0	15.0	88.3	1.6
Bromus japonicus	8.3	1.7	--	--	5.0	5.0	--	--
Buchloe dactyloides	50.0	6.7	28.3	1.7	80.0	6.6	96.6	3.3
Carex heliophila	11.7	1.7	1.7	1.7	50.0	0.0	35.0	18.3
Festuca spp.	--	--	3.3	3.3	--	--	--	--
Koeleria cristata	--	--	1.7	1.7	--	--	--	--
Stipa comata	1.7	1.7	--	--	18.3	1.6	--	--
Stipa viridula	1.7	1.7	--	--	1.6	1.6	--	--
Unknown grass	8.3	8.3	--	--	--	--	--	--
Forb:								
Allium spp.	48.3	5.0	--	--	--	--	--	--
Antennaria spp.	--	--	--	--	--	--	--	--
Astragalus crassicarpus	--	--	--	--	1.6	1.6	--	--
Astragalus spp.	1.7	1.7	--	--	6.6	3.3	5.0	1.6
Chenopodium alba	3.3	0.0	3.3	3.3	--	--	--	--
Chrysothamnus nauseosus	--	--	--	--	--	--	8.3	1.6
Descurania pinnata	51.7	1.7	--	--	--	--	--	--
Erysimum asperum	8.3	5.0	5.0	1.7	--	--	--	--
Grindelia squarrosa	28.3	5.0	30.0	10.0	23.3	10.0	--	--
Hedoma drummondi	1.7	1.7	--	--	1.6	1.6	--	--
Helianthus petiolaris	20.0	10.0	--	--	--	--	--	--
Holosteum umbulatum	1.7	1.7	--	--	--	--	--	--
Hydrophyllia spp.	1.7	1.7	--	--	--	--	--	--
Kochia scoparia	--	--	1.7	1.7	--	--	--	--
Lappula redowskii	61.7	8.3	--	--	6.6	3.3	--	--
Lepidium densiflorum	--	--	45.0	45.0	--	--	--	--
Lepidium virginicum	100.0	0.0	--	--	--	--	--	--
Liatris punctata	--	--	--	--	--	--	33.3	10.0
Linum rigidum	6.7	6.7	--	--	--	--	--	--
Medicago lupilina	10.0	3.3	18.3	1.7	3.3	3.3	--	--
Melilotus officianalis	30.0	0.0	20.0	3.3	--	--	1.6	1.6
Musineon divaricatum	16.7	3.3	3.3	3.3	--	--	--	--
Opuntia spp.	6.7	0.0	3.3	0.0	1.6	1.6	5.0	5.0
Phlox hoodii	5.0	1.7	--	--	18.3	5.0	3.3	3.3
Plantago spp.	5.0	1.7	--	--	--	--	--	--
Sphaeralcea coccinea	10.0	6.7	10.0	0.0	--	--	21.6	1.6
Thlaspi arvense	20.0	6.7	16.7	6.7	--	--	--	--
Trifolium spp.	--	--	--	--	6.6	6.6	10.0	3.3
Vicia spp.	23.3	6.7	--	--	--	--	1.6	1.6
Unknown forb	1.7	1.7	1.7	1.7	--	--	8.3	1.6

PERCENT FREQUENCY BY SPECIES

HANSON'S

Species	1978 Spring $\bar{x}$	1978 Spring SE	1978 Fall $\bar{x}$	1978 Fall SE	1979 Spring $\bar{x}$	1979 Spring SE	1979 Fall $\bar{x}$	1979 Fall SE
Shrub:								
Artemesia dracunculoides	--	--	--	--	3.3	0.0	10.0	10.0
Artemesia cana	--	--	--	--	5.0	5.0	--	--
Artemesia filifolia	1.7	1.7	--	--	--	--	--	--
Artemesia frigida	--	--	--	--	--	--	10.0	10.0
TOTALS	685.2	108.8	351.6	95.1	362.7	79.4	416.2	82.7